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LASER-BASED STUDIES OF MOLECULAR ION DYNAMICS IN THE
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PHYSICS AND ASTRONOMY J M WILLER 83 JUN 86
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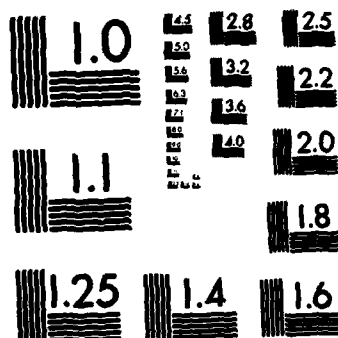
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) Laser equipment was purchased under the DoD University Research Instrumentation Program. The report lists the equipment purchased, primarily consisting of an argon-ion laser and a ring dye laser, and describes how this equipment is being set up in conjunction with a flowing afterglow apparatus to study the photodissociation of positive and negative molecular ions, and the photodetachment of negative ions. Future uses of the equipment are outlined.					
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FINAL REPORT, AFOSR-85-0128

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MATTHEW J. KERPER

Chief, Technical Information Division

"Laser-Based Studies of Molecular Ion Dynamics in the Earth's Atmosphere"

Thomas M. Miller, Department of Physics and Astronomy, University of Oklahoma,
Norman, OK 73019

This report describes equipment purchased under a grant from DoD's
University Research Instrumentation Program, and its usage.

EQUIPMENT ACQUIRED

The specific equipment acquired is exactly as named in the final
negotiated budget for this grant, except for the source of the optical table.
The equipment acquired is listed below.

1. Laser Equipment

From Coherent Laser Products Division
13109 Velma Place NE
Albuquerque, NM 87112
(505) 296-6300

A. Argon-ion laser, model INNOVA-20, with extended warranty including replacement plasma tube	\$ 66,292
B. Ring dye laser, model 699-05	36,398
C. Frequency doubler, model 7500	8,590
D. Spectrum analyzer, model 216PP	3,850
E. Power meter, model 205	1,633
F. Freight charge	792
Subtotal	117,555

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2. Optical Table

From Technical Manufacturing Corp.
 15 Centennial Dr.
 Peabody, MA 01960
 (617) 532-6330

A. Table top, model 76-459-2	\$ 4,340
B. Isolation supports, model 62-125	1,975
C. Freight charge	350
Subtotal	<u>6,665</u>

Total DoD-URIP Equipment	\$124,220
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3. Set-Up and Facility Modification

The University of Oklahoma is spending approximately \$20,000 to increase the electric power capacity of Nielsen Hall where the above equipment resides, to handle the laser power and to provide for future requirements. Of this, \$5,050 is considered to be matching funds for the present DoD grant. The University is absorbing a \$16 mail charge and the \$220 difference between the equipment cost in (1) and (2) and the grant amount.

RESEARCH EFFORT

The laser equipment listed above has been set up in the Department of Physics and Astronomy at the University of Oklahoma, contiguous to a flowing



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afterglow/mass spectrometer apparatus, primarily for photodissociation and photodetachment studies.¹ The flowing afterglow is a versatile ion source for simple and complex ions. During the 1984/85 academic year the principal investigator was on sabbatic at the Joint Institute for Laboratory Astrophysics and spent much of this time finding ways of producing negative ions in the flowing afterglow apparatus at JILA using a microwave discharge cavity from the Oklahoma machine. These ions were then studied spectroscopically via photodetachment. This work covered simple atomic ions² which had not been made before in a flowing afterglow; diatomic rhenium negative ions,³ for the first time; the diatomic alkali-halide negative ions,⁴ likewise for the first time; a variety of triatomic ions such as CHF^- , CF_2^- , and HCO^- ;^{6,7} large negative ion clusters of sodium fluoride - microcrystals;⁸ and electrostatic cluster ions such as H_3O^- and $\text{O}_2^-\cdot\text{O}_2$ and $\text{O}_2^-\cdot\text{H}_2\text{O}$.⁹ A fixed-frequency laser was utilized for photodetaching these ions.

The work being pursued at the University of Oklahoma is similar in that a flowing afterglow ion source is used, but differs in that tunable dye laser radiation impinges on the ions while they are still in the afterglow. The attenuation of the mass-analyzed parent ion signal yields a relative photodestruction (photodissociation or photodetachment) cross section versus wavelength. These cross sections may be put on an absolute scale by normalization to H^- , O^- , or O_2^- photodetachment cross sections.¹ Our hope with the laser equipment purchased is to be able to obtain results in the infrared and ultraviolet regimes as well as in the visible. Because the grant period only covers the year in which the equipment was ordered, delivered, and set up, there has only been time for exploratory research which is in a very preliminary stage.

We have plans for collaboration with others on this campus, using the new equipment.

(a) The Department of Chemistry has a new research project in which the chemistry of transition metal ion complexes will be studied in a flowing afterglow apparatus; we anticipate that in many cases it will prove useful to probe the structure of these ions with the laser apparatus in Nielsen Hall.

(b) In the Department of Physics and Astronomy an apparatus is being built to measure oscillator strengths in metal vapors, with particular relevance to fusion plasmas and stellar atmospheres. We expect that this apparatus will be moved near the DoD-URIP laser equipment so that the high-powered tunable dye laser may be used to cover a great many metal atom transitions.

(c) In the Department of Chemical Engineering research is in progress on reactions with various biologically-active systems. We hope to use the flowing afterglow to analyze vapors given off from these reactions. Again, the laser equipment has only been set up for a few months, so all of these projects lie in the future.

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